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(54) **ARMOUR ARRANGEMENT**

PANZERANORDNUNG

BLINDAGE

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(73) Proprietor: **Bae Systems Land Systems South Africa (PTY) Limited**  
**1501 Benoni (ZA)**

(72) Inventor: **NEETHLING, Rufus Stephanus**  
**1401 Germiston (ZA)**

(74) Representative: **Jenkins, Peter David**  
**Page White & Farrer**  
**Bedford House**  
**John Street**  
**London WC1N 2BF (GB)**

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**Description****FIELD OF THE INVENTION**

[0001] The invention relates to an armour arrangement, and more particularly, but not exclusively, to an armour arrangement suitable for use with armoured vehicles to protect a surface of the vehicle from shaped charges.

**BACKGROUND TO THE INVENTION**

[0002] A shaped charge is an explosive charge shaped to focus the effect of the explosive's energy. Various types of shaped charges are used to cut and form metal, initiate nuclear weapons, and penetrate armour. A typical device consists of a solid cylinder of explosive with a metal-lined conical hollow in one end and a central detonator, array of detonators, or detonation wave guide at the other end. The enormous pressure generated by the detonation of the explosive drives the liner contained within the hollow cavity inward to collapse upon its central axis. The resulting collision forms and projects a high-velocity jet of metal forward along the axis. Most of the jet material originates from the innermost layer of the liner, about 10% to 20% of its thickness. The remaining liner material forms a slower-moving slug of material.

[0003] A typical modern lined shaped charge can penetrate armour steel to a depth of 7 or more times the diameter of the charge's cone.

[0004] A shaped charge is also known as an Explosively Formed Penetrator or Explosively Formed Projectile (or "EFP" for short), Explosively-Formed Projectile, Explosively-Formed Penetrator, Self-Forging Warhead (SFW), and Self-Forging Fragment (SFF).

[0005] Shaped-charges and explosively formed projectiles are of major concern in modern day warfare, since they are relatively easy to produce and highly effective in penetrating armour plating of a light armour vehicle.

[0006] Composite armour, where sheets of different materials are located and secured atop one another, have been used with limited success heretofore, but do not prove to be sufficiently effective against the new threats of shaped charges and EFP's.

[0007] An example of known composite armour is laminate glass armour, which comprises silica/polycarbonate plastic layers sandwiched between glass layers. Disadvantages of laminate glass armour are that it is relatively very expensive to produce and relatively very heavy, since a sheet of laminate glass is approximately 3 inches thick and weights approximately 30 Lb/Ft<sup>2</sup>. DE2815582 discloses a multi-layer bullet proof glass structure, wherein at least one layer thereof includes a plurality of small units made of oxide ceramics and/or sintered metal disposed in a matrix of moulded polyurethane, nylon or similar synthetic resin.

**OBJECT OF THE INVENTION**

[0008] It is accordingly an object of the invention to provide an armour arrangement that will, at least partially, alleviate the disadvantages of existing solutions.

[0009] It is a further object of the invention to provide an armour arrangement that will be a useful alternative to existing armour arrangements.

**10 SUMMARY OF THE INVENTION**

[0010] According to the invention there is provided an armour arrangement as defined in claim 1.

[0011] The disruption members may be arranged substantially parallel relative to one another.

[0012] Each disruption member may have a first impact side, being the side distal from the protected surface, and a second exit side, being the side proximate the protected surface, the arrangement being such that the armour arrangement includes a first impact face, being the face formed by the impact sides of the disruption members, and a second exit face, being the face formed by the exit sides of the disruption members.

[0013] The exit side of one disruption member may at the least partially overlap an adjacently positioned disruption member.

[0014] The disruption members may be of a non-linear configuration, wherein an angle between the impact side of the member and the protected surface is different to an angle between the exit side of the member and the protected surface.

[0015] Each disruption body may be planar.

[0016] Alternatively, each disruption body may be arcuate.

[0017] The disruption bodies may be connected to one another to form the disruption member by the retaining frame, which may define a plurality of openings for receiving opposite outer ends of the bodies.

[0018] Alternatively, the disruption bodies may be connected to one another by being bonded to one another.

[0019] The armour arrangement may be positioned in front of the surface to be protected by being attached thereto by attachment means.

[0020] The surface may be the external surface of a hull section of an armoured vehicle.

**BRIEF DESCRIPTION OF THE DRAWINGS**

[0021] The invention will now be described further by way of a non-limiting example with reference to the accompanying drawings wherein:

figure 1 is a perspective view of an armour arrangement according to a preferred embodiment of the invention, being partially assembled;

figure 2 is a perspective view of the armour arrangement of figure 1, being assembled;

figure 3 is a cross sectional side view of the armour arrangement of figures 1 and 2; and

figure 4 is a schematic illustration of the armour arrangement of figures 1 to 3, used in examples 1 and 2.

## DESCRIPTION OF A PREFERRED EMBODIMENT OF THE INVENTION

[0022] Referring to the drawings, an armour arrangement according to a preferred embodiment of the invention is generally designated by reference numeral 10.

[0023] The armour arrangement 10 is used to cover a surface (not shown) to be protected, such as an outer surface of a hull of an armoured vehicle (all not shown). The armour arrangement 10 is positioned in front of and is secured to the surface, by attachment means (also not shown).

[0024] The armour arrangement 10 comprises a plurality of disruption members 12 located adjacent one another, being at least partially spaced apart from one another and being angularly displaced relative to the surface.

[0025] Each disruption member 12 has a first impact side 14 and a second exit side 16. The first impact side 14 is the side distal from the protected surface and the second exit side 16 is the side proximate the protected surface. The arrangement is therefore such that the armour arrangement 10 has a first impact face 18, which is formed by the first impact sides 14 of the disruption members 12, and a second exit face 20, which is formed by the second exit sides 16 of the disruption members 12.

[0026] The disruption members 12 are arranged substantially parallel relative to one another with the exit side 16 of one disruption member 12 at the least partially overlapping the disruption member 12 positioned adjacent it. The disruption members 12 are of a non-linear configuration, wherein an angle between the impact side 14 of the member 12 and the protected surface is different to an angle between the exit side 16 of the member 12 and the protected surface.

[0027] Each disruption member 12 is arcuate in cross-section and includes three disruption bodies (jointly referred to as 22), a first body 22.1, a second body 22.2 and a third body 22.3. The disruption bodies 22 are planar and positioned side-by-side to form the arcuate disruption member 12. The bodies 22 are further arranged in an angularly offset configuration, such that each disruption member 12 is in the shape of a half-parabolic curve. Specifically, the angle of the first body 22.1, relative to the horizontal, is approximately 60°, the angle of the second body 22.2, relative to the horizontal, is approximately 45°, and the angle of the third body 22.3, relative to the horizontal, is approximately 30°.

[0028] The disruption bodies 22 are all made of 5 mm thick armour plate steel, with a Brinell hardness of between 500 and 600, such as Armox500™. The first body

22.1 is 30 mm wide and the second and third bodies 22.2 and 22.3 are both 25 mm wide each.

[0029] The disruption bodies 22 are connected to one another to form the disruption member 12 by a retaining frame 24, as shown in figures 1 and 2. The retaining frame 24 defines a plurality of openings 26 for receiving opposite outer ends of the bodies 22. However, the disruption bodies 22 could also be bonded to one another by, for example, having their adjacent ends welded together.

[0030] Below, as two examples, are the set up and results of trials that have been conducted to test the functionality of the armour arrangement 10, as described above.

### Example 1

[0031] Referring to figure 4, the armour arrangement 10 in this example comprises three disruption bodies 22.1, 22.1 and 22.3, each being 5 mm thick and made from RAMOR500™ armour plate, having a Brinell hardness of 500. The first body 22.1 is 42.5 mm wide, the second body 22.2 is 23.5 mm wide and the third body 22.3 is 17mm wide. The angle of the first body 22.1, relative to the horizontal, is 63°, the angle of the second body 22.2, relative to the horizontal, is 46°, and the angle of the third body 22.3, relative to the horizontal, is 18°.

[0032] The armour arrangement 10 was positioned in front of the hull section of an armoured vehicle, with the exit face 20 of the armour arrangement 10 facing the surface of the hull and being approximately 435 mm from the surface.

[0033] An EFP was fired at the armour arrangement 10 from 2 m perpendicularly in front of the armour arrangement 10.

[0034] It was found that the combination of the armour arrangement 10 and the hull of the armoured vehicle ward off the EFP. There were only minor splatter markings on the outer surface of the hull. The EFP thus had no effect on the inside of the hull.

### Example 2

[0035] Using the same armour arrangement 10 described in example 1 above, the armour arrangement 10 was positioned approximately 321 mm from the surface of the hull. The EFP was again fired 2 m from the armour arrangement 10. In this trial, the outer surface of the hull was relatively more damaged, but the EFP still did not penetrate the hull.

[0036] It has been shown that the damage sustained by armour plates during physical shaped-charge impact is based on the capability of the shaped charge to melt the material, which it is impacting. Further confirmation of this observation is the presence of splatter-patterns, consistent with molten metal droplets. It can therefore be concluded that a shaped-charge (or EFP) is most accurately modelled or approximated by the assumption that

it is a phenomenon with:

- i) High-speed (momentum/kinetic energy)
- ii) High temperature (thermal energy)
- iii) High pressure
- iv) High viscosity (molten metal)
- v) A spearhead-shape
- vi) A molten/fluid metal slug or "jet" consistency

**[0037]** It is therefore submitted that in order to avoid death or serious injury due to a blast, one either needs to avoid the blast or the blast should be absorbed or deflected.

**[0038]** In the same vein, it is submitted that one can generalise and apply this philosophy to shaped charges too. Unfortunately, avoidance is quite improbable, thus the only two remaining options are absorption (dissipation through momentum redistribution) or deflection (redirection of the jet to avoid impact).

**[0039]** The basic concept of the present invention is to (i) deflect the molten metal jet as much as possible or, partially failing that, to (ii) dissipate the concentrated linear momentum of the single slug or jet by spreading it over a larger area (henceforth called splattering or scattering) by forcing it to break into smaller parts and changing its direction of motion through collision phenomena.

**[0040]** The former objective (deflection) would ideally be best facilitated by having a deflector-channel-shaped arrangement of plates which present a surface with a very high NATO (North Atlantic Treaty Organisation) impact angle at the point of first impact, gradually transitioning to one having an impact angle parallel to or smaller than the surface tangent vector of the main armour behind it.

**[0041]** The latter objective (dissipation or disruption) would ideally be achieved by placing as many as possible thin (ca. 1 mm thick) plates at a slant to "disrupt" the flow (i.e. redirect, redistribute and convert the linear momentum) as many times as possible.

**[0042]** It has been found that thicker disruption bodies 22 provide more protection and deflection capability per body 22, whilst the thinner bodies 22 provide more disruptive capability.

**[0043]** It has further been found that the multi-layered slanted body layout of the armour arrangement 10 proves to be effective in disrupting and diverting the jet originating from an EFP. There is a trade-off between structural strength and mass per unit area (which is attempted to be kept under 100 kg/m<sup>2</sup>).

**[0044]** It will be appreciated that variations in detail are possible with an armour arrangement according to the invention without departing from the scope of the appended claims.

**[0045]** For example, the disruption members could each be formed from a single sheet of material, instead of a plurality of disruption bodies connected to one another. The disruption members could further be planar or arcuate formed by bending a single plate of material, to form a continuous smooth shape.

**[0046]** Further, the number of disruption bodies making up the disruption member may vary and the shape of the disruption bodies could be arcuate instead of planar.

## Claims

1. An armour arrangement (10) for covering an external surface of an armoured vehicle to be protected, the armour arrangement (10) comprising a plurality of disruption members (12) being located adjacent to one another, at least partially spaced apart from one another and being angularly displaced relative to the surface to be protected, wherein each disruption member (12) comprises a plurality of disruption bodies (22) that are arranged relative to one another, such that the disruption member (12) is in the shape of a half-parabola, wherein the armour arrangement (10) comprises a retaining frame (24), and the disruption members (12) are located within the frame (24).
2. An armour arrangement (10) according to claim 1 wherein the disruption members (12) are arranged substantially parallel relative to one another.
3. An armour arrangement (10) according to claim 1 or claim 2 wherein each disruption member (12) has a first impact side (14), being the side distal from the protected surface, and a second exit side (16), being the side proximate the protected surface, the arrangement being such that the armour arrangement (10) includes a first impact face (18), being the face formed by the impact sides (14) of the disruption members (12), and a second exit face (20), being the face formed by the exit sides (16) of the disruption members (12).
4. An armour arrangement (10) according to claim 3 wherein the exit side (16) of one disruption member (12) at the least partially overlaps an adjacently positioned disruption member (12).
5. An armour arrangement (10) according to claim 3 or 4 wherein the disruption members (12) are of a non-linear configuration and wherein an angle between the impact side (14) of the member (12) and the protected surface is different to an angle between the exit side (16) of the member (12) and the protected surface.

6. An armour arrangement (10) according to claim 1 wherein each disruption body (22) is planar.
7. An armour arrangement (10) according to claim 1 wherein each disruption body (22) is arcuate.
8. An armour arrangement (10) according to claim 1 wherein the disruption bodies (22) are connected to one another, to form the disruption member (12), by the retaining frame (24), which defines a plurality of openings (26) for receiving opposite outer ends of the bodies (22).
9. An armour arrangement (10) according to claim 1 wherein the disruption bodies (22) are connected to one another by being bonded to one another.
10. An armour arrangement (10) according to any one of the preceding claims which is positioned in front of the surface to be protected by being attached thereto by attachment means.
11. An armour arrangement (10) according to claim 10 wherein the surface is the external surface of a hull section of an armoured vehicle.

#### Patentansprüche

1. Panzeranordnung (10) zum Abdecken einer äußeren Oberfläche eines zu schützenden Panzerfahrzeugs, wobei die Panzeranordnung (10) mehrere Störelemente (12) umfasst, die nebeneinander liegen, mindestens teilweise voneinander beabstandet sind und relativ der zu schützenden Oberfläche winklig versetzt sind, wobei die Störelemente (12) jeweils mehrere Störkörper (22) umfassen, die derart relativ zueinander angeordnet sind, dass das Störelement (12) die Form einer Halbparabel aufweist, wobei die Panzeranordnung (10) einen Halterahmen (24) umfasst und die Störelemente (12) in dem Rahmen (24) liegen.
2. Panzeranordnung (10) nach Anspruch 1, wobei die Störelemente (12) im Wesentlichen parallel relativ zueinander angeordnet sind.
3. Panzeranordnung (10) nach Anspruch 1 oder Anspruch 2, wobei die Störelemente (12) jeweils eine erste Aufprallseite (14) aufweisen, bei der es sich um die von der geschützten Oberfläche distale Seite handelt und eine zweite Austrittsseite (16) aufweisen, bei der es sich um die zur geschützten Oberfläche proximalen Seite handelt, wobei die Anordnung derart ist, dass die Panzeranordnung (10) eine erste Aufprallfläche (18) umfasst, bei der es sich um die von den Aufprallseiten (14) der Störelemente (12) gebildete Fläche handelt und eine zweite Aus-

trittsfläche (20) aufweist, bei der es sich um die von den Austrittsseiten (16) der Störelemente (12) gebildete Fläche handelt.

- 5 4. Panzeranordnung (10) nach Anspruch 3, wobei die Austrittsseite (16) eines Störelements (12) mindestens teilweise ein daneben positioniertes Störelement (12) überlappt.
- 10 5. Panzeranordnung (10) nach Anspruch 3 oder 4, wobei die Störelemente (12) eine nichtlineare Ausbildung aufweisen und wobei ein Winkel zwischen der Aufprallseite (14) des Elements (12) und der geschützten Oberfläche von einem Winkel zwischen der Austrittsseite (16) des Elements (12) und der geschützten Oberfläche verschieden ist.
- 15 6. Panzeranordnung (10) nach Anspruch 1, wobei die Störkörper (22) jeweils ebenflächig sind.
- 20 7. Panzeranordnung (10) nach Anspruch 1, wobei die Störkörper (22) jeweils bogenförmig sind.
- 25 8. Panzeranordnung (10) nach Anspruch 1, wobei die Störkörper (22) durch den Halterahmen (24), der mehrere Öffnungen (26) zum Aufnehmen gegenüberliegender äußerer Enden der Körper (22) definiert, miteinander verbunden sind, um das Störelement (12) zu bilden.
- 30 9. Panzeranordnung (10) nach Anspruch 1, wobei die Störkörper (22) miteinander verbunden sind, indem sie festhaftend miteinander verbunden sind.
- 35 10. Panzeranordnung (10) nach einem der vorangehenden Ansprüche, die vor der zu schützenden Oberfläche positioniert ist, indem sie durch Befestigungsmittel daran befestigt ist.
- 40 11. Panzeranordnung (10) nach Anspruch 10, wobei es sich bei der Oberfläche um die äußere Oberfläche eines Rumpfabschnitts eines Panzerfahrzeugs handelt.

#### Revendications

1. Agencement de blindage (10) pour couvrir une surface extérieure d'un véhicule blindé destiné à être protégé, l'agencement de blindage (10) comprenant une pluralité d'éléments de perturbation (12) lesquels sont disposés en position adjacente l'un par rapport à l'autre, au moins partiellement espacés l'un de l'autre et déplacés de façon angulaire par rapport à la surface destinée à être protégée, cas dans lequel chaque élément de perturbation (12) comporte une pluralité de corps de perturbation (22) qui sont agencés l'un par rapport à l'autre de sorte que l'élément

- de perturbation (12) se présente sous la forme d'une demi-parabole, cas dans lequel l'agencement de blindage (10) comporte un cadre de maintien (24), et les éléments de perturbation (12) sont positionnés à l'intérieur du cadre (24). 5
2. Agencement de blindage (10) selon la revendication 1, les éléments de perturbation (12) étant agencés suivant un plan sensiblement parallèle l'un à l'autre. 10
3. Agencement de blindage (10) selon la revendication 1 ou la revendication 2, chaque élément de perturbation (12) possédant un premier côté d'impact (14), qui est le côté distal par rapport à la surface protégée, et un second côté de sortie (16), qui est le côté proximal de la surface protégée, l'agencement étant tel que l'agencement de blindage (10) comporte une première face d'impact (18), qui est la face formée par les côtés d'impact (14) des éléments de perturbation (12), et une seconde face de sortie (20), qui est la face formée par les côtés de sortie (16) des éléments de perturbation (12). 15  
20
4. Agencement de blindage (10) selon la revendication 3, le côté de sortie (16) d'un élément de perturbation (12) chevauchant tout au moins partiellement un élément de perturbation (12) disposé en position adjacente. 25
5. Agencement de blindage (10) selon la revendication 3 ou 4, les éléments de perturbation (12) ayant une configuration non linéaire, et un angle entre le côté d'impact (14) de l'élément (12) et la surface protégée étant différent d'un angle entre le côté sortie (16) de l'élément (12) et la surface protégée. 30  
35
6. Agencement de blindage (10) selon la revendication 1, chaque corps de perturbation (22) ayant une forme plane. 40
7. Agencement de blindage (10) selon la revendication 1, chaque corps de perturbation (22) ayant une forme arquée.
8. Agencement de blindage (10) selon la revendication 1, les corps de perturbation (22) étant raccordés l'un à l'autre, afin de former l'élément de perturbation (12), grâce au cadre de maintien (24) qui définit une pluralité d'ouvertures (26) pour recevoir les extrémités externes opposées des corps (22). 45  
50
9. Agencement de blindage (10) selon la revendication 1, les corps de perturbation (22) étant raccordés l'un à l'autre du fait qu'ils sont liaisonnés l'un à l'autre. 55
10. Agencement de blindage (10) selon l'une quelconque des revendications précédentes, qui est positionné devant la surface destinée à être protégée du fait qu'il y est fixé grâce à des moyens de fixation.
11. Agencement de blindage (10) selon la revendication 10, la surface étant la surface extérieure d'une section de coque d'un véhicule blindé.

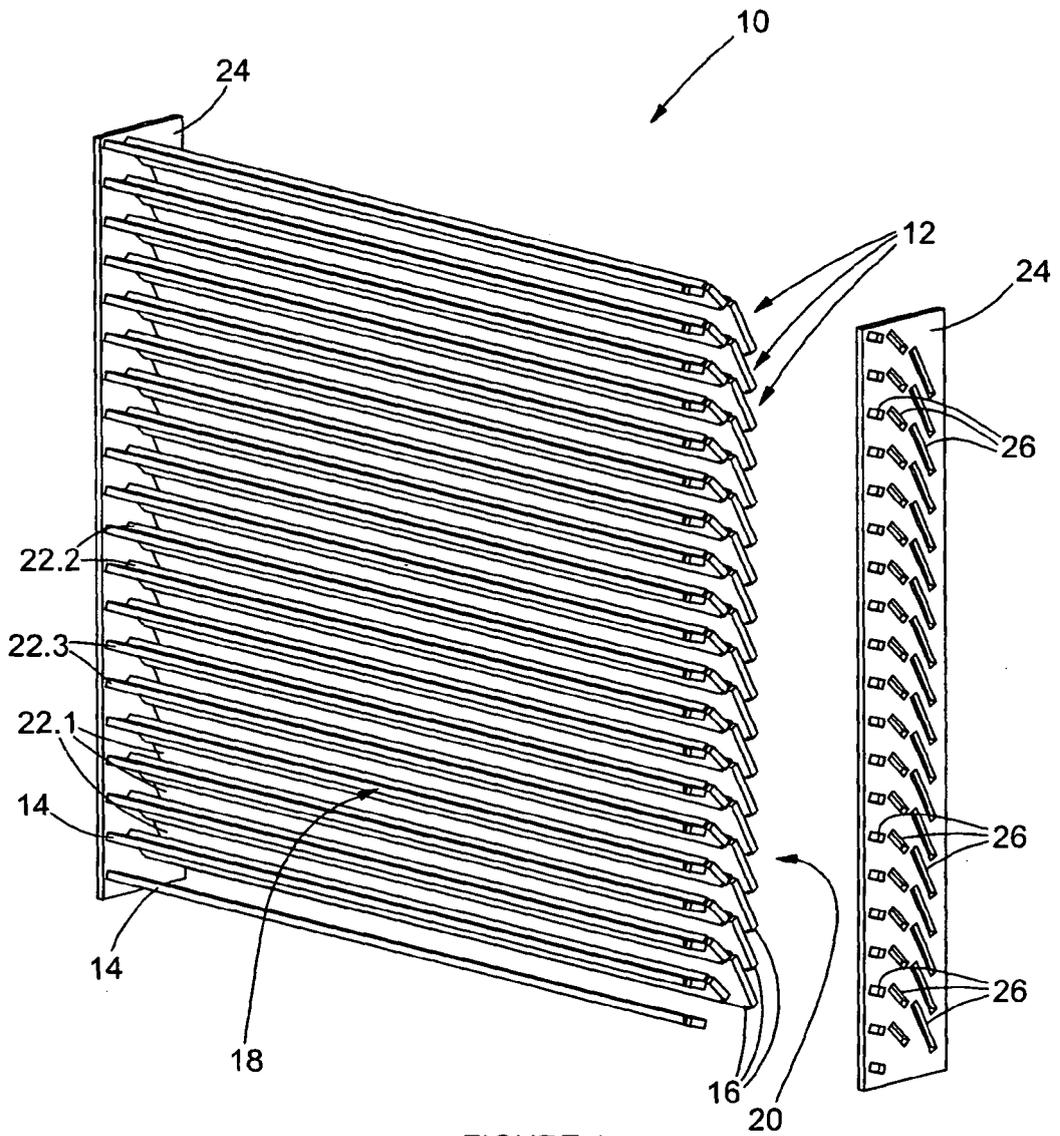


FIGURE 1

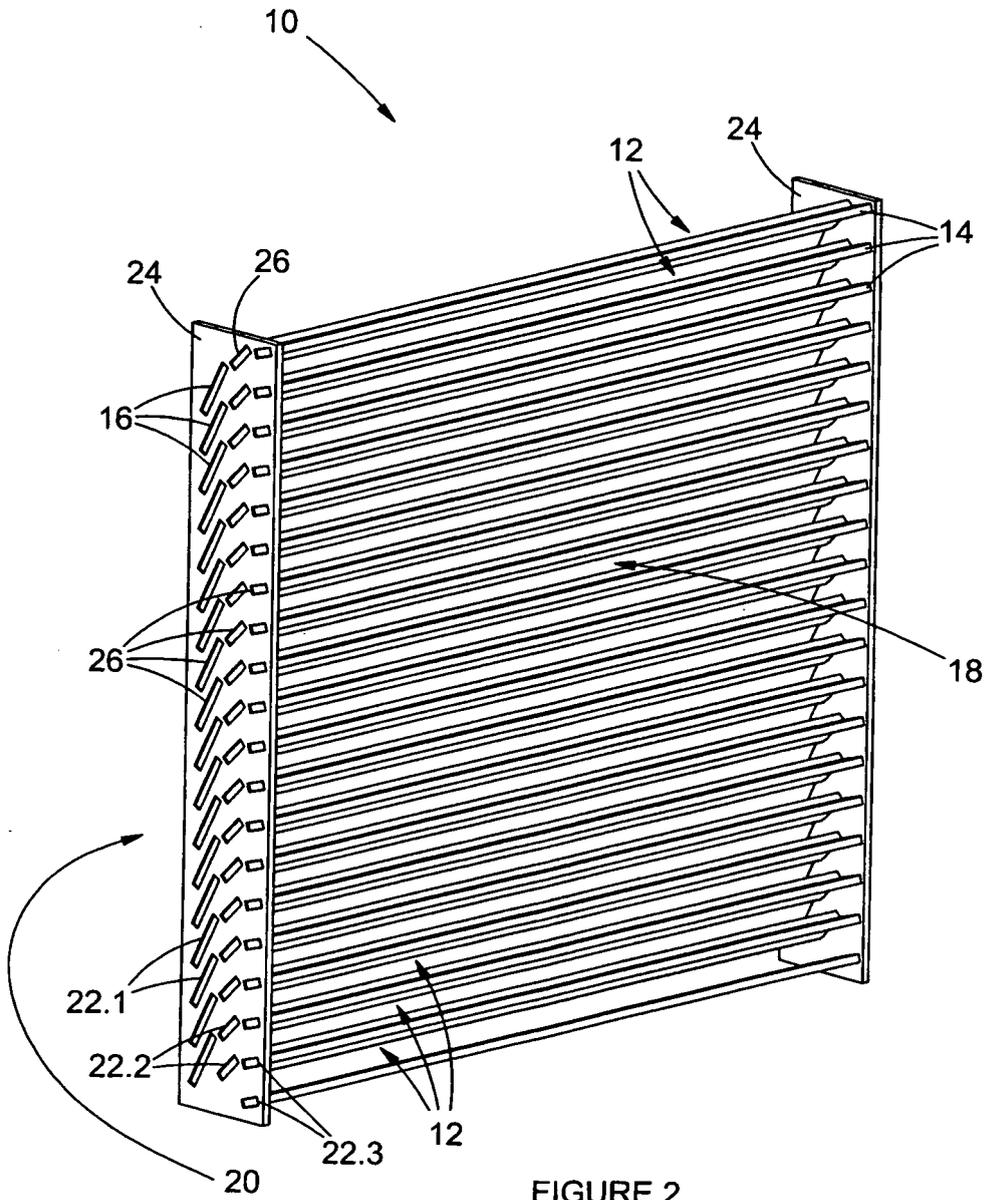


FIGURE 2

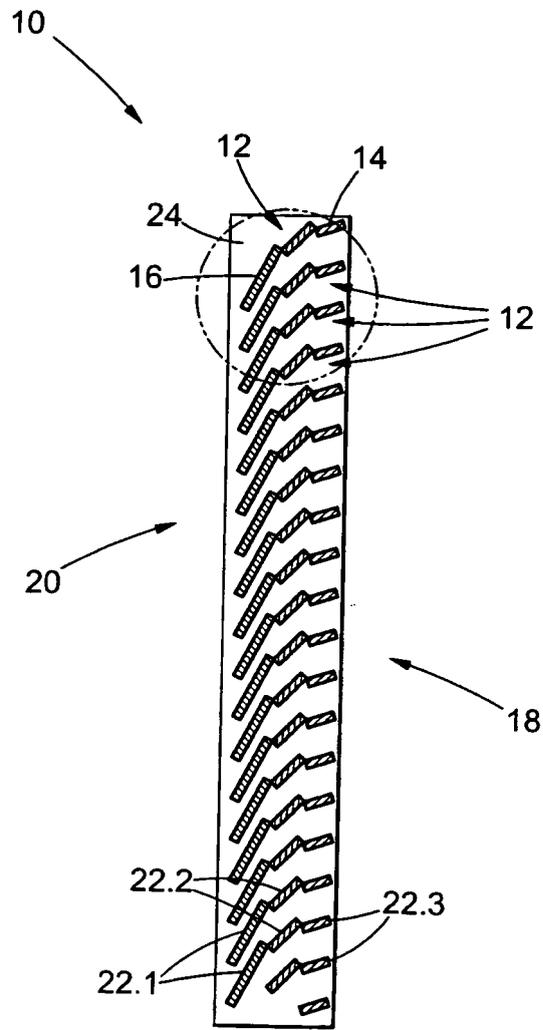


FIGURE 3

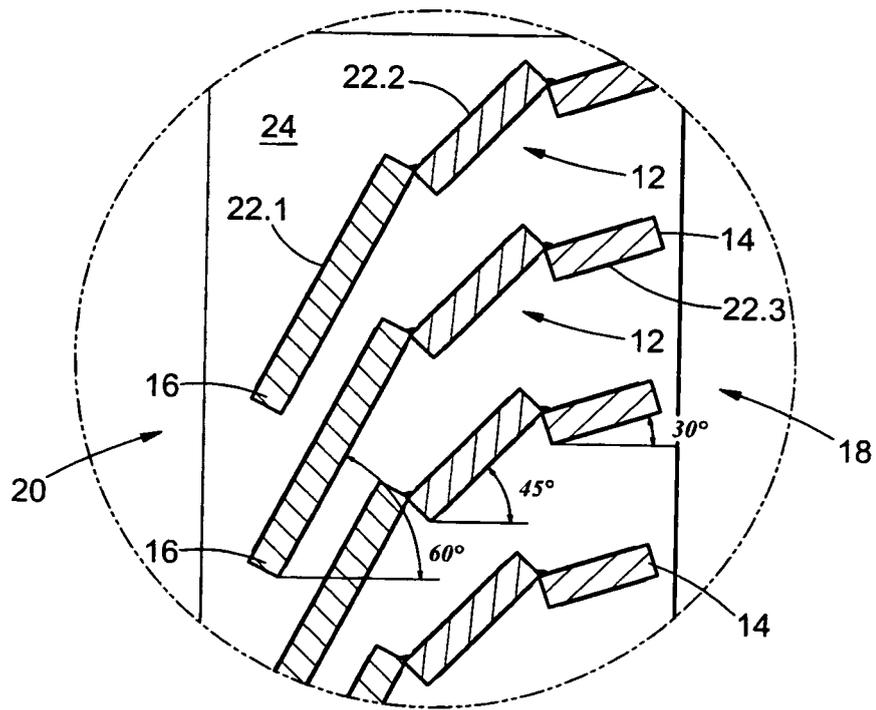


FIGURE 4

**REFERENCES CITED IN THE DESCRIPTION**

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